PATENT SPECIFICATION

Application Date: April 30, 1937. No. 12375/37.

494,734

Complete Specification Left: April 29, 1938.

Complete Specification Accepted: Oct. 31, 1938.

PROVISIONAL SPECIFICATION

Improvements in Radio Receivers

We, MURPHY RADIO LIMITED, a company organised and existing under the laws of Great Britain, of 62/64, Brook Street, Hanover Square, London, W.1, and GEOFFREY BERNARD BAKER, a British subject, of Murphy Radio Works, Broadwater Road, Welwyn Garden City, Herts, do hereby declare the nature of this invention to be as follows:—

To prevent impairment of reception through inexact tuning—particularly likely in radio receivers equipped with automatic volume control and particularly harmful in superheterodyne receivers—receivers have been provided with means of automatic tuning correction which give them signal-seeking properties, so that when nearly tuned by hand to an incoming signal they bring themselves into almost exact tune with it. Preferred schemes of automatic tune correction are described in specification 443,423.

It may be found impossible to tune such receivers to a weak signal in the presence of a strong neighbouring unwanted signal unless the automatic tuning correction is put out of action during the tuning by hand; and when the receiver is tuned to a signal, if that signal fades badly the receiver may be automatically returned to a neighbouring strong unwanted signal.

To remedy this the present invention provides that the means of automatic tuning correction shall automatically be rendered inoperative when the signal falls below a predetermined value.

In general the means of automatic tuning correction is made up of an error detector, including a discriminating circuit or circuits which produce a voltage varying with the error in tuning, and a tune corrector, governed by that voltage, which alters the tuning of the receiver. Automatic tune correction may be suppressed by interrupting either the input or the output of the error detector, or by short-circuiting the error detector at any convenient point. Such interruption or short-circuiting may be effected by an electro-magnetically-operated switch, the excitation of the electromagnet depending on the strength of the received signal. Where automatic volume control is employed the anode current of the controlled valve or valves, which increases as the signal weakens, may be used to excite the switch magnet. Where noise suppression is provided by varying the current of a low frequency amplifying valve, that current may be used to excite the magnet, and the latter scheme is preferable inasmuch as there is greater selectivity in the receiver prior to the low frequency valve than prior to the feed point of the automatic volume control circuits, and therefore there is the less likelihood of an unwanted signal being strong enough at the point of control to affect the electro-magnet.

It is better to dispense with moving parts and to employ a thermionic valve or valves rather than an electromagnetic switch; but it is desirable to avoid placing any extraneous bias upon the leads which carry the output voltage of the error detector, otherwise the calibration of the receiver will be rendered incorrect.

In order that the description of such valve circuits may not be too abstract it may be assumed that the automatic tune correcting means contemplated is one of those described in the specification above mention; say an error detector consisting of discriminating circuits tuned respectively above and below intermediate frequency, fed through condensers from an intermediate frequency circuit and feeding resistance-loaded diodes which have a common cathode or connected cathodes; and a tune corrector consisting of what is in that specification termed a thermionic reactance, which is a thermionic valve associated with external circuits which make its anode-cathode or grid-cathode impedance a high power-factor reactance varying with the bias on a grid of the valve; the bias is provided by the error detector, and the thermionic reactance forms part of the tuned circuit of the local oscillator.

If the anodes of the error detector diodes are connected together the voltages across the respective diode loads will become equal, and their difference which is applied to the thermionic reactance will be zero. The connection need not be a

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direct current connection, provided it is of low impedance for intermediate frequencies; and as the diode circuits are of high impedance the connection between the anodes will effectively short-circuit them even if its impedance be of the order of 50,000 ohms. The connection may, therefore, be effectively made by the anode-cathode path of a triode, and can be effectively broken by sufficient negative bias on the valve grid.

The diode anodes, however, are at a high intermediate frequency potential which makes it undesirable to place the short-circuiting valve between. It is preferably placed between tappings on the discriminating circuits nearer to chassis potential, the impedance of the connecting valve being made smaller in proportion to the square of the tapping ratio. To provide the tappings the inductance of each discriminating circuit is divided into large and small parts (say nine tenths and one tenth) separated by a blocking condenser; the large parts are used to supply the diodes loads while the small parts are included in the anode and cathode circuits respectively of the connecting valve. To reduce the valve impedance it is provided with external circuits which make it a thermionic impedance of suitable value for its short-circuit function; for example a condenser of 100$\mu\mu$f between anode and grid will form with the grid-cathode inter-electrode capacity a suitable potentiometer to give the anode-cathode impedance a minimum value of 300 ohms, corresponding to the above-suggested 10:1 tapping ratio. Automatic bias, such as the automatic volume control bias, is applied to the grid of the valve and can reduce its slope to a low value, or zero.

There being still a voltage across the load of each diode the equalisation of the two load voltages for the purpose of the present invention does not prevent the application of the load voltage for noise suppression in the manner described in specification No. 453,858.

Where such noise-suppression is employed, by taking the bias of the short-circuiting valve from the anode current of the low frequency valve which effects noise-suppression, the automatic tuning correction may be suppressed so long as the noise-suppression is in operation. As it is found in practice that a receiver is not automatically re-tuned to an unwanted signal until the wanted signal has faded beyond the limit at which noise-suppression operates, automatic tuning suppression so adjusted will wholly prevent such shift of tune.

For the purpose of this scheme the low frequency amplifying pentode by which noise suppression is effected has a self-biasing resistance in its cathode circuit, its cathode is connected to the cathode of the short-circuiting valve, and its suppressor grid is connected to the common cathode terminal of the error detector diodes, the outer end of one diode load resistance being connected to the chassis. A potentiometer is bridged between the anode of the pentode and chassis and a tapping upon it applies a small fraction of the anode voltage to the grid of the short-circuiting valve through a high resistance. In the absence of a signal the suppressor grid of the pentode is at chassis potential, and therefore the pentode is biassed to anode current cut-off by the voltage drop in its cathode resistance. In this condition there is a small negative bias on the short-circuiting valve due to the difference between the voltage tapped from the potentiometer and that in the cathode circuit resistance. When a signal sufficiently loads the diodes to lessen the pentode suppressor grid bias to a point where the pentode passes a small current, the anode voltage of the pentode drops (there being a substantial resistance between the anode and high tension positive), the tapped portion of it no longer nearly balances the self bias, and the short-circuiting valve is biassed to cut-off, whereupon the error detector begins to affect the tune corrector.

It is preferable to carry the anode circuit of the short-circuiting valve not direct to high tension positive but to the anode of the pentode, and to give the short-circuiting valve sufficient anode-grid capacity to make it of low impedance for audio as well as intermediate frequencies. The potentiometer will then not serve to bias the grid of the short-circuiting valve; and the less bias now required may conveniently be taken from the load of the signal rectifying diode. Noise-suppression will be improved, for the low-impedance short-circuiting valve loading the pentode will diminish its amplification.

The putting out of action of the noise suppression means as the receiver approaches the tune of a signal may be made to occur within a very small range of intermediate frequency variation by establishing a conductive connection between the anode of the short-circuiting valve and the grid of the pentode, and between the anode of the latter and the grid of the former.

An error detector consisting of the two off-tune circuits may also be put out of action by bringing its discriminating circuits more nearly into tune with each

other; which may be done by including a thermionic reactance in one of them. The thermionic reactance may be governed as above explained by the anode voltage of a noise-suppressing pentode, which in turn may be governed by the diode load.

Dated this thirteenth day of April, 1937.

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COMPLETE SPECIFICATION

Improvements in Radio Receivers

We, MURPHY RADIO LIMITED, a company organised and existing under the laws of Great Britain, of 62/64, Brook Street, Hanover Square, London, W.1, and GEOFFREY BERNARD BAKER, a British subject, of Murphy Radio Works, Broadwater Road, Welwyn Garden City, Herts, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

To prevent impairment of reception through inexact tuning—particularly likely in radio receivers equipped with automatic volume control and particularly harmful in superheterodyne receivers—receivers have been provided with means of automatic tuning correction which give them signal-seeking properties, so that when nearly tuned by hand to an incoming signal they bring themselves into almost exact tune with it. The means of automatic tuning correction include an error detector which produces a bias voltage dependent on the error in tuning and a tune corrector controlled by that bias voltage. Preferred schemes of automatic tune correction are described in specification 443,423; in these tune correction is effected by a thermionic impedance, as there defined, effectively forming part of the oscillatory circuit of the local oscillator.

It may be found impossible to tune such receivers to a weak signal in the presence of a strong neighbouring unwanted signal unless the automatic tuning correction is put out of action during the tuning by hand; and when the receiver is tuned to a signal, if that signal fades badly the receiver may be automatically retuned to a neighbouring strong unwanted signal.

To remedy this it has been proposed to rectify energy taken from the intermediate frequency circuit and employ it to operate an electro-magnetic switch by which the error detector is cut off from the tune corrector when the received signal strength falls below a predetermined value. It has also been proposed to employ bias derived from a noise suppression circuit not only to close the signal channel, by biassing to cut-off an intermediate frequency valve but also to bias to cut-off a valve through which the error detector is supplied.

The present invention leaves the supply to the error detector unaffected and makes no use of mechanical switches. Instead it reduces to zero the voltage which the error detector supplies to the tune corrector by the aid of a valve directly connected to the error detector and taking current from it. The valve is controlled by bias dependent on the amplitude of the signal so that the error detector is rendered inoperative upon the tune corrector when the signal falls below a predetermined value.

In general the error detector may be rendered inoperative by effectively short-circuiting it, so as to reduce to zero the governing bias it applies to the tune corrector. Several forms of error detector include tuned circuits, for instance a single tuned circuit of a frequency slightly different from intermediate frequency, or two tuned circuits of frequencies respectively slightly higher and slightly lower than intermediate frequency; in these cases the controlling valve may form part of a thermionic impedance and serve to tune the circuit of one or both of the circuits of the error detector, for instance by bringing a single tuned circuit to intermediate frequency or by bringing the two tuned circuits to the same frequency, and thereby reducing to zero the voltage produced by the error detector when the signal fades.

Where the receiver is equipped with noise-suppression operating on a low frequency valve, the bias governing the valve or thermionic impedance which short-circuits the error detector or otherwise acts on its output circuit to make it inoperative on the tune corrector may be derived from the noise suppression circuit, in which case automatic tuning may readily be arranged to go out of action when noise suppression comes into action.

The invention may with advantage be

combined with noise suppression in another way, namely by connecting an anode thermionic impedance used for short-circuiting the error detector in parallel with the noise suppression valve, thereby loading the latter when automatic tuning is put out of action and improving the noise suppression.

Examples of these various methods of carrying out the invention are further described below with reference to the accompanying drawings.

Figure 1 shows a thermionic impedance used for short-circuiting the error detector and governed by the bias used for automatic volume control.

Figure 2 shows short-circuiting of the error detector by a thermionic impedance governed by a low frequency valve used for noise suppression.

Figure 3 shows a thermionic impedance used for tuning one of the discriminating circuits of the error detector.

In each example the type of error detector shown consists of two oscillatory circuits 1, 2 tuned the one a little above and the other a little below intermediate frequency, and supplied through condensers 3 from an intermediate frequency stage 4 of the signal channel. Each circuit supplies a rectifier 5 loaded by a condenser-shunted resistance 6. The rectifiers are shown as having a common cathode at which the resistances 6, 6 are connected together; between their outer ends, therefore, a voltage arises which is the difference between the rectified voltages in the two resistances, and this is applied through the lead 7 to the tune corrector. A condenser 8 is interposed in the connection of the circuit 1 to chassis in order that the resistances may not be short-circuited.

To render the error detector inoperative it is sufficient to connect together the points 9 and 10, so that the same voltage is applied to each rectifier 5; the error detector, considered as such, is thereby short-circuited, though a voltage, the same voltage, is still produced in each of the resistances 6, and may be employed as explained in specification 453,858 for the purpose of noise suppression.

The error detector may be effectively short-circuited without making a direct current connection between the points 9, 10; the connection need only be of low impedance for intermediate frequencies. Since the diode circuits are of high impedance a connection between the anodes will effectively short-circuit the error detector even if its impedance be of the order of 50,000 ohms. The connection may, therefore, be effectively made by the anode-cathode path of a triode, and can be effectively broken by sufficient negative bias on the valve grid.

The diode anodes, however, are at a high intermediate frequency potential which makes it undesirable to place the short-circuiting valve between them. It is preferably placed between tappings on the discriminating circuits nearer to chassis potential as shown in Figure 1, the impedance of the connecting valve being made smaller in proportion to the square of the tapping ratio. To provide the tappings the inductance of each discriminating circuit 1, 2 is divided into large and small parts 14, 15, the former being, say, nine times the impedance of the latter, separated by a blocking condenser 16; the large parts 14 are used to supply the diode loads 6 while the small parts 15 are included in the anode and cathode circuits respectively of the connecting valve 17. To reduce the valve impedance it is provided with external circuits which make it a thermionic impedance of suitable value for its short-circuiting function; for example a condenser 18 of $100\mu\mu f$ between anode and grid will form with the grid-cathode inter-electrode capacity (indicated by dotted lines) a suitable potentiometer to give the anode-cathode impedance a minimum value of 300 ohms, corresponding to the above suggested 10:1 tapping ratio. Automatic bias, such as the automatic volume control bias, is applied to the grid of the valve 17 through lead 19 and can reduce its slope to a low value, or zero.

Where noise-suppression is employed, by taking the bias of the short-circuiting valve from the anode current of the low frequency valve which effects noise-suppression, the automatic tuning correction may be suppressed so long as the noise-suppression is in operation. As it is found in practice that a receiver is not automatically re-tuned to an unwanted signal until the wanted signal has faded beyond the limit at which noise suppression operates, automatic tuning suppression so adjusted will wholly prevent such shift of tune.

For the purpose of this scheme, illustrated in Figure 2, the low frequency amplifying pentode 20 by which noise suppression is effected has a self-biasing resistance 21 in its cathode circuit, its cathode is connected to the cathode of the short-circuiting valve 17, and its compressor grid is connected to the common cathode terminal of the error detector diodes 5, the outer end of one diode low resistance 6 being connected to the chassis. A potentiometer 22, 23 is bridged between the anode of the pentode

20 and chassis and a tapping upon it applies a small fraction of the anode voltage to the grid of the short-circuiting valve 17 through a high resistance 24. In the absence of a signal the suppressor grid of the pentode 20 is at chassis potential, and therefore the pentode is biassed to anode current cut-off by the voltage drop in its cathode resistance 21. In this condition there is a small negative bias on the short-circuiting valve 17 due to the difference between the voltage tapped from the potentiometer 22, 23 and that in the cathode circuit resistance. When a signal sufficiently loads the diodes 5 to lessen the pentode suppressor grid bias to a point where the pentode 20 passes a small current, the voltage of the pentode anode drops (there being a substantial resistance 25 between its anode and high tension positive), the tapped portion of it no longer nearly balances the self bias due to 21, and the short-circuiting valve 17 is biassed to cut-off, whereupon the error detector begins to affect the tune corrector.

It is preferable to carry the anode circuit of the short-circuiting valve 17 not direct to high tension positive but to the anode of the pentode 20, and to give the short-circuiting valve 17 sufficient anode-grid capacity to make it of low impedance for audio as well as intermediate frequencies. The potentiometer 22, 23 will then not serve to bias the grid of the short-circuiting valve 17; and the less bias now required may conveniently be taken from the load of the signal rectifying diode. Noise-suppression will be improved, for the low impedance short-circuiting valve 17 loading the pentode will diminish its amplification.

The establishment of a conductive connection between the anode of the pentode and the grid of the short-circuiting valve causes the putting out of action of the noise suppression means as the receiver approaches the tune of a signal to occur within a very small range of intermediate frequency variation.

An error detector consisting of two off-tune circuits may also be put out of action by bringing its discriminating circuits 1, 2 more nearly into tune with each other; which may be done by including a thermionic reactance in one of them. This is shown in Figure 3 where the valve 17 is bridged by a potentiometer consisting of a high resistance 26 of small capacity, and a condenser 27, which applies to the grid of the valve a fraction of the anode voltage approximately in quadrature with the anode voltage. The valve and potentiometer behave as an inductance variable by variation of the bias on the outer grid. This bias may be drawn, as above explained, from the anode voltage of a noise-suppressing pentode, which in turn may be governed by the diode load. On the signal failing the right hand circuit 2 is tuned to approximately the same frequency as the left hand circuit, and the error detector therefore produces no tune-correcting bias.

A similar method may be employed where the error detector has but one off-tune circuit, by using the thermionic reactance to bring the tune to intermediate frequency.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A radio receiver having means of automatic tune correction comprising an error detector producing a bias voltage on the error in tuning, and a tune corrector controlled by that bias voltage, in which the error detector includes a valve or thermionic impedance controlled by bias dependent on the amplitude of the signal and connected directly to the error detector so as, by taking current from it, to render it inoperative upon the tune corrector when the signal falls below a determined magnitude.

2. A radio receiver according to claim 1 having also noise suppression operating on the signal channel subsequent to the point from which the error detector is fed, in which the valve or thermionic impedance of the error detector is controlled by the noise suppression circuit, so that the error detector is rendered inoperative upon the tune corrector when noise suppression comes into operation.

3. A radio receiver according to claim 1 in which the valve or thermionic impedance in effect short-circuits the error detector.

4. A superheterodyne radio receiver according to claim 1 in which the error detector includes oscillatory circuits tuned above and below intermediate frequency respectively supplying resistance-loaded rectifiers to produce a voltage difference for biassing the tune corrector, and the valve or thermionic impedance bridges the input terminals of or, preferably, tappings on these circuits so that the voltage difference vanishes through the output voltage of each circuit remains substantial.

5. A superheterodyne radio receiver according to claim 1 in which the error detector includes an oscillatory circuit or two oscillatory circuits normally tuned to a frequency slightly different from inter-

mediate frequency, and in which the thermionic impedance varies the tune of said circuit or of one or both of said circuits, to render the error detector inoperative when the amplitude of the signal is small.

6. The circuits for automatic suppression of automatic tuning correction on fading of the signal above described and shown in the accompanying drawings.

Dated this 29th day of April, 1938.

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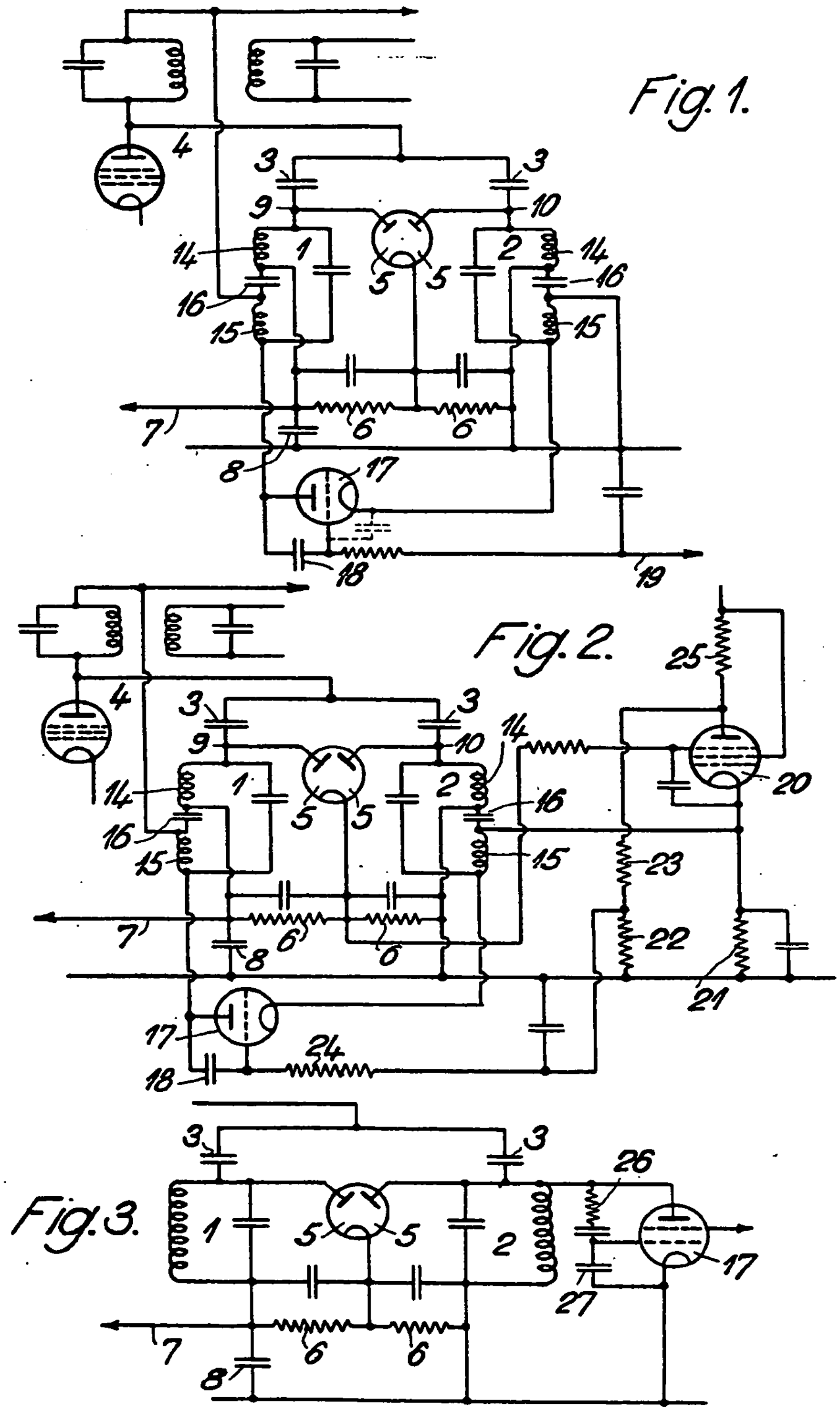
Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1938.



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